

CLAIMS

1. A method for decoding a linear code on ring R , the method being characterized by including:

5 a low-density processing step for reducing the density of elements whose values are determined to be one, for a check matrix of the linear code; and

a decoding step for decoding the linear code through a sum product algorithm by using the check matrix whose density is reduced through the low-density processing step.

10 2. The decoding method according to Claim 1, characterized in that the ring is a finite field including powers of prime numbers, as elements.

3. The decoding method according to Claim 2, characterized in that the linear code includes a BCH code, 15 or a Reed-Solomon code on the finite field.

4. The decoding method according to Claim 1, characterized in that the low-density processing step includes:

20 a linear-combination calculation step for calculating linear combination of rows of the check matrix; and

a check-matrix generation step for extracting a subset of lower-weight vectors for forming a complementary space from among a vector set obtained by the linear combination calculated through the linear-combination calculation step 25 and generating a new check matrix including all the vectors

of the vector subset, as row elements.

5. The decoding method according to Claim 4, characterized in that the low-density processing step further includes:

5 an expansion step for expanding the check matrix on the finite field on a predetermined subfield of the finite field in a predetermined degree,

 wherein the linear-combination calculation step is provided for calculating linear combination of the rows of
10 the check matrix expanded through the expansion step.

6. A decoder for a linear code on ring R, the decoder being characterized by including:

 low-density processing means that performs low-density processing for reducing the density of elements whose values
15 are determined to be one, for a check matrix of the linear code; and

 decoding means for decoding the linear code through a sum product algorithm by using the check matrix whose density is reduced by the low-density processing means.

20 7. The decoder according to Claim 6, characterized in that the ring is a finite field including powers of prime numbers, as elements.

 8. The decoder according to Claim 7, characterized in that the linear code includes a BCH code, or a Reed-Solomon
25 code on the finite field.

9. The decoder according to Claim 6, characterized in that the low-density processing means includes:

linear-combination calculation means for calculating linear combination of rows of the check matrix; and

5 check-matrix generation means for extracting a subset of lower-weight vectors for forming a complementary space from among a vector set obtained by the linear combination calculated by the linear-combination calculation means and generating a new check matrix including all the vectors of
10 the vector subset, as row elements.

10. The decoder according to Claim 9, characterized in that the low-density processing means further includes expansion means for expanding the check matrix on the finite field on a predetermined subfield of the finite field in a
15 predetermined degree,

wherein the linear-combination calculation means calculates linear combination of rows of the check matrix expanded through the expansion means.

11. The decoder according to Claim 6, characterized by
20 further including soft-decision decoding means for performing soft-decision decoding for a linear code subjected to convolutional encoding,

wherein the low-density processing means reduces the density of the elements whose values are determined to be
25 one, for the check matrix of the linear code subjected to

the soft-decision decoding by the soft-decision decoding means.

12. The decoder according to Claim 11, characterized in that the soft-decision decoding by the soft-decision
5 decoding means, the low-density processing by the low-density processing means, and the decoding by the decoding means are repetitively performed.

13. A program for making a computer decode a linear code on ring R , characterized in that the computer is made to
10 perform processing including:

a low-density processing step for reducing the density of elements whose values are determined to be one, for a check matrix of the linear code; and

a decoding step for decoding the linear code through a
15 sum product algorithm by using the check matrix whose density is reduced through the low-density processing step.

14. A method for decoding a linear code on ring R , the decoding method being characterized by including:

an input step for inputting a reception value; and

20 a decoding step for decoding the linear code through a sum product algorithm, for a check matrix of the linear code, by using the check matrix, where the density of elements whose values are determined to be one is reduced, and the reception value input through the input step.

25 15. A decoder for a linear code on ring R , the decoder

being characterized by including:

input means for inputting a reception value; and

decoding means for decoding the linear code through a
sum product algorithm, for a check matrix of the linear code,
5 by using the check matrix, where the density of elements
whose values are determined to be one is reduced, and the
reception value input by the input means.

16. A program for making a computer decode a linear code
on ring R , characterized in that the computer is made to
10 perform processing including:

an input step for inputting a reception value; and

a decoding step for decoding the linear code through a
sum product algorithm, for a check matrix of the linear code,
by using the check matrix, where the density of elements
15 whose values are determined to be one is reduced, and the
reception value input through the input step.

17. A recording-and-reproducing apparatus for recording
data onto a recording medium and reproducing the data
recorded on the recording medium, the recording-and-
20 reproducing apparatus being characterized by including:

recording means for recording a linear code on ring R
on the recording medium;

reproducing means for reproducing the linear code
recorded by the recording means;

25 low-density processing means that performs low-density

processing for reducing the density of elements whose values are determined to be one, for a check matrix of the linear code reproduced by the reproducing means; and

5 decoding means for decoding the linear code through a sum product algorithm by using the check matrix whose density is reduced by the low-density processing means.

18. The recording-and-reproducing apparatus according to Claim 17, characterized in that the linear code is a linear code subjected to product coding in a predetermined degree,

10 the low-density processing means performs the low-density processing for the check matrix for each degree, and

the decoding means performs decoding through the sum product algorithm for each degree of the low-density check matrix.

15 19. A recording-and-reproducing apparatus according to Claim 17, characterized in that the low-density processing by the low-density processing means and the decoding by the decoding means are repetitively performed.

20 20. A recording-and-reproducing method for a recording-and-reproducing apparatus for recording data onto a recording medium and reproducing the data recorded on the recording medium, the recording-and-reproducing method being characterized by including:

a recording-control step for having control over
25 recording a linear code on ring R onto the recording medium;

a reproducing-control step for having control over reproducing the linear code recorded under the control of the recording-control step;

5 a low-density processing step for performing low-density processing for reducing the density of elements whose values are determined to be one, for a check matrix of the linear code reproduced under the control of the reproducing-control step; and

10 a decoding step for decoding the linear code through a sum product algorithm by using the check matrix whose density is reduced through the low-density processing step.

21. A program for making a computer record data onto a recording medium and reproduce the data recorded on the recording medium, the program being characterized in that
15 the computer is made to perform processing including:

a recording-control step for having control over recording a linear code on ring R onto the recording medium;

20 a reproducing-control step for having control over reproducing the linear code recorded under the control of the recording-control step;

a low-density processing step for performing low-density processing for reducing the density of elements whose values are determined to be one, for a check matrix of the linear code reproduced under the control of the
25 reproducing-control step; and

a decoding step for decoding the linear code through a sum product algorithm by using the check matrix whose density is reduced through the low-density processing step.

22. A recording-and-reproducing apparatus for recording
5 data onto a recording medium and reproducing the data recorded on the recording medium, the recording-and-reproducing apparatus being characterized by including:

recording means for recording a linear code on ring R onto the recording medium;

10 reproducing means for reproducing the linear code recorded by the recording means;

decoding means for decoding the linear code through a sum product algorithm, for a check matrix of the linear code, by using the check matrix, where the density of elements
15 whose values are determined to be one is reduced.

23. A recording-and-reproducing method for a recording-and-reproducing apparatus for recording data onto a recording medium and reproducing the data recorded on the recording medium, the recording-and-reproducing method being
20 characterized by including:

a recording-control step for having control over recording a linear code on ring R onto the recording medium;

a reproducing-control step for having control over reproducing the linear code recorded under the control of
25 the recording-control step;

a decoding step for decoding the linear code through a sum product algorithm, for a check matrix of the linear code, by using the check matrix, where the density of elements whose values are determined to be one is reduced.

5 24. A program for making a computer record data onto a recording medium and reproduce the data recorded on the recording medium, the program being characterized in that the computer is made to perform processing including:

10 a recording-control step for having control over recording a linear code on ring R onto the recording medium;

 a reproducing-control step for having control over reproducing the linear code recorded under the control of the recording-control step; and

15 a decoding step for decoding the linear code through a sum product algorithm, for a check matrix of the linear code, by using the check matrix, where the density of elements whose values are determined to be one is reduced.

20 25. A reproducing apparatus for reproducing data recorded on a recording medium, the reproducing apparatus being characterized by including:

 reproducing means for reproducing a linear code on ring R recorded on the recording medium;

25 low-density processing means for performing low-density processing for reducing the density of elements whose values are determined to be one, for a check matrix of the linear

code reproduced by the reproducing means; and

decoding means for decoding the linear code through a sum product algorithm by using the check matrix whose density is reduced by the low-density processing means.

5 26. The reproducing apparatus according to Claim 25, characterized in that the linear code is a linear code subjected to product coding in a predetermined degree,

the low-density processing means performs the low-density processing for the check matrix for each degree, and

10 the decoding means performs decoding through the sum product algorithm for each degree of the low-density check matrix.

27. The reproducing apparatus according to Claim 25, characterized in that the low-density processing by the low-
15 density processing means and the decoding by the decoding means are repetitively performed.

28. A reproducing method for a reproducing apparatus for reproducing data recorded on a recording medium, the reproducing method being characterized by including:

20 a reproducing control step for controlling reproduction of a linear code on ring R recorded on the recording medium;

 a low-density processing step for performing low-density processing for reducing the density of elements whose values are determined to be one, for a check matrix of
25 the linear code reproduced under the control of the

reproducing control step; and

a decoding step for decoding the linear code through a sum product algorithm by using the check matrix whose density is reduced through the low-density processing step.

5 29. A program for making a computer reproduce data recorded on a recording medium, the program being characterized in that the computer is made to perform processing including:

a reproducing control step for controlling reproduction
10 of a linear code on ring R recorded on the recording medium;

a low-density processing step for performing low-density processing for reducing the density of elements whose values are determined to be one, for a check matrix of the linear code reproduced under the control of the
15 reproducing control step; and

a decoding step for decoding the linear code through a sum product algorithm by using the check matrix whose density is reduced through the low-density processing step.

20 30. A reproducing apparatus for reproducing data recorded on a recording medium, the reproducing apparatus being characterized by including:

reproducing means for reproducing a linear code on ring R recorded on the recording medium; and

decoding means for decoding the linear code through a
25 sum product algorithm, for a check matrix of the linear code,

by using the check matrix, where the density of elements whose values are determined to be one is reduced.

31. A reproducing method for a reproducing apparatus for reproducing data recorded on a recording medium, the
5 reproducing method being characterized by including:

a reproducing control step for controlling reproduction of a linear code on ring R recorded on the recording medium; and

10 a decoding step for decoding the linear code through a sum product algorithm, for a check matrix of the linear code, by using the check matrix, where the density of elements whose values are determined to be one is reduced.

32. A program for making a computer reproduce data recorded on a recording medium, the program being
15 characterized in that the computer is made to perform processing including:

a reproducing control step for controlling reproduction of a linear code on ring R recorded on the recording medium; and

20 a decoding step for decoding the linear code through a sum product algorithm, for a check matrix of the linear code, by using the check matrix, where the density of elements whose values are determined to be one is reduced.